IR-COATED HALOGEN LAMP USING REFLECTIVE END COATS

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates generally to halogen infrared lamps with reflective coatings on the lamp envelope. More particularly, this invention relates to halogen infrared lamps coated with an infrared reflective coating substantially surrounding the entire envelope along with a totally reflecting coating disposed on ends of an ellipsoidal portion of the envelope.

Discussion of the Art

Improving the efficiency of lamps is increasingly important due to the rising cost of energy. Infrared reflective filters, a form of interference filters, have been used to improve the energy efficiency of lamps by reflecting infrared radiation towards the filament to heat the filament and thus increase the efficacy of the lamp. Interference filters have also been used to selectively reflect or transmit light radiation from certain portions of the electromagnetic radiation spectrum such as ultraviolet, visible, and infrared radiation. Interference filters have been used to allow a portion of the visible radiation to transmit through the envelope and reflecting the unwanted visible radiation to produce colored light.

A halogen infrared (HIR) lamp uses an infrared (IR) reflective coating on an elliptical surface of a double ended quartz halogen lamp to preferentially reflect IR radiation to a filament. This coating, however, allows some IR radiation to pass since the reflectivity in the IR region is not one hundred percent. Metal halide discharge lamps have used reflective end-coats to improve the efficacy of lamps by heating up the ends where a metal halide pool forms, thereby increasing the vapor pressure of the pool and therefore the efficacy. Moreover, computer modeling has

the IR radiation lost at these particular angles by using an additional reflective end-coating, similar to metal halide discharge lamps, it is believed that the efficacy of the lamp can be improved.

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to a totally reflecting coating placed near the ends of a HIR lamp to reflect visible and IR radiation at low acute angles and large obtuse angles as measured from an axis defined along the filament. The totally reflecting coating reflects visible and IR radiation towards the filament to heat the filament. Due to the fact that more IR radiation is lost at these angles compared to visible light, the net effect is to return more IR radiation to the coil, thereby heating the coil and increasing the efficacy of the lamp.

The light source is comprised of a light transmissive lamp envelope having a filament centrally disposed within the envelope. The envelope described above has an ellipsoidal portion located centrally between two tubular portions disposed on opposite ends of the ellipsoidal portion. An IR reflective coating substantially surrounds the entire ellipsoidal portion of the envelope and a totally reflecting coating is located on ends of the envelope.

A pair of lead wires are connected to opposite ends of the filament. In another embodiment, the light source may have lead wires extending from only one end of the lamp.

One exemplary embodiment of the lamp has an IR reflective filter coating containing alternate layers of materials with different refractive indices. These different refractive indices allow desired radiation through while reflecting the unwanted radiation. The present invention advantageously provides a totally reflecting coating near the ends of the HIR lamp to preferentially reflect the IR radiation that usually would escape and direct it towards the filament.

The totally reflecting coating on both ends of the envelope preferably subtends an angle from approximately 22° to approximately 45° from the filament axis and surrounding the entire envelope.

A primary benefit of the invention resides in the increased efficacy associated with the subject lamp.

Another benefit of the invention relates to the simple manner in which efficacy of the lamp can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates an HIR lamp in accordance with one embodiment of the present invention.

FIGURE 2 illustrates an HIR lamp in accordance with a second exemplary embodiment of the present invention.

FIGURES 3 and 4 are a graphical representation of the radiation emitted from the lamp in the visible and IR regions, respectively, relative to the angle from the lamp axis.

FIGURE 5 is an elevational view partially in cross-section of a directional lighting system (PAR 38 reflector) employing features of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Exemplary embodiments of the invention are shown in FIGURES 1 and 2 and illustrate a light source or lamp **100** comprising a double-ended envelope **102**

connected at first ends by first and second lead wires **110, 112**, respectively. The envelope **102** contains a halogen gas and a fill-gas. The halogen gas in the present invention is a halogen mixed with methyl bromide; however, other gas mixtures are encompassed by the scope of the present invention. The fill gas is preferably selected from the group consisting of xenon, krypton, argon and mixtures of these gases with nitrogen.

The filament **104** extends longitudinally along a major axis of the ellipsoidal portion of the envelope **102**. In the preferred embodiment, the filament **104** is a tungsten material and is a coiled-coil type filament, although other filament material and configurations are not outside the scope of the present invention. First and second seals **114, 116** are provided at opposite ends of the envelope **102** in a manner that is well known in the art.

An IR reflective film **118** is provided on the outer surface of the envelope **102**. In the preferred embodiment, the IR reflective film **118** is deposited on the envelope **102** by vapor deposition or sputtering; however, the IR film **118** may be deposited on the envelope **102** by other methods. The IR reflective film **118** acts in concert with the ellipsoidal shape of the envelope **102** and the placement of the filament **104** along the major axis **A** of the ellipsoidal portion of the envelope **102** to perform multiple functions. First, the IR film **118** reflects IR radiation emitted by the lamp towards the filament **104** in order to increase the efficacy of the light source **100**. Second, the IR film **118** allows other portions of the radiated spectrum, including visible radiation emitted by the filament **104**, to pass through the envelope **102**.

It is desired, though not necessary, that the IR film **118** have the optical and temperature properties similar to the filter disclosed in U.S. Patent No. 4,229,066. The IR film **118** of the exemplary embodiment is a composite or a plurality of stacked layers comprised of alternating high refractive materials and low refractive materials. The IR film has transmittance and reflectance characteristics capable of withstanding [illegible] effectively at an elevated temperature of, for example 600° Celsius, for a

[illegible] 102 [illegible]

In the first embodiment, as shown in FIGURE 1, the totally reflecting coating **120** is disposed on both ends of the envelope **102** subtending an angle from approximately twenty two degrees (22°) to approximately forty five degrees (45°) from the major axis **A** of the ellipsoidal portion of the envelope at each end (i.e., also extending from one hundred thirty five degrees (135°) to approximately one hundred fifty eight degrees (158°) from the major axis). In the second embodiment, illustrated in FIGURE 2, the totally reflecting coating **120** is disposed on both ends of the ellipsoidal portion of the envelope **102** subtending an angle from approximately twenty two degrees (22°) to approximately forty five degrees (45°) from the major axis **A** of the envelope, as well as covering at least a portion of the tubular portions of the envelope. Preferably the portion of each tubular portion surrounding the seal region is not coated. The totally reflecting coating **120** can be made from silver, aluminum or any other desired reflective material exhibiting similar properties.

In developing the invention, it was determined that IR radiation escapes the envelope **102** even when it is covered by the IR reflective coating **118**. In particular, the coating is less effective at acute angles measuring less than approximately thirty degrees (30°) from the major axis **A** of the ellipsoidal portion of the envelope **102** and at obtuse angles measuring approximately one hundred fifty (150°) from the major axis. The totally reflecting coating reflects the IR radiation (as well as the visible radiation) that is escaping at these angles towards the filament. By preferentially reflecting this IR radiation (and also the visible radiation) towards the filament **102** that would otherwise pass through a lamp envelope having only an IR film, the efficacy of the light source **100** is improved. In the first embodiment as shown in FIGURE 1 the totally reflecting coating is disposed on both ends of the envelope subtending an angle from approximately twenty two (22°) to approximately forty five degrees (45°) from the major axis (or as measured to the opposite end as an obtuse angle from approximately one hundred thirty five degrees (135°) to one hundred fifty eight degrees (158°)) of the ellipsoidal portion of the envelope **102**. In the second embodiment of FIGURE 2, the totally reflecting coating **120** is disposed on

preferentially reflecting this IR radiation towards the filament **102**, the efficacy of the light source **100** is improved.

FIGURES 3 and 4 are graphical representations of a modeled angular distribution of output radiation in the visible and IR regions, respectively. As is evident, there are peaks at approximately thirty degrees (30°) and one hundred fifty degrees (150°) for the IR radiation. Thus, by recapturing the IR radiation at the low angles, i.e., zero to thirty degrees (0°-30°) and one hundred fifty to one hundred eighty degrees (150°-180°), through use of the additional reflective end coat, the efficacy is improved. Since it is believed that the IR reflection is based on the angle of incidence, the empirical model was validated qualitatively by subsequent measurement. The visible region, as represented in FIGURE 3, starts to reflect at the extreme angles, thus resulting in the graphical representation of FIGURE 3.

It is estimated that lamp efficacy may be improved on the order of approximately four percent (4%) by using the totally reflective end coatings on the ends of the envelope. The end coats are relatively inexpensive to add since they involve only a single layer and the technology of coating silver, aluminum, or a similarly functional reflector material is well known.

Although there is consideration that heating of the tubes in the embodiment of FIGURE 2 where the reflective coating extends to the tubular portions, and may effect the pinch seal on the molybdenum foil, the benefits offered by improved efficacy will dictate the optimization and the exact placement or extent of the coating.

It will also be appreciated that when the filament tube is used in a directional lighting system, the system can be optimized by matching the reflective end coat region with the desired reflecting areas of the reflector. Thus, as illustrated in FIGURE 5, the useful emitting angles of the filament tubes are alpha (α) and gamma (γ), so that total reflective layers made of aluminum, nichrome, or other material which ensures specular reflection enhances the efficacy of the overall system.

reading and understanding of this specification. For example, although a double-ended envelope is illustrated, single-ended lamps where the lead wires extend from the same end of the lamp are also contemplated. The invention is intended to include all such modifications and alteration in so far as they come within the scope of the appended claims or the equivalents thereof.